precommitted for week $t + 2$, packers will desire to purchase "few" spot market cattle in week $t + 1$ (for delivery in week $t + 2$), with this easing of demand having the tendency to reduce the spot market price in week $t + 1$. Thus, it would appear that the intertemporal shifting of non-cash cattle deliveries, and the accommodating intertemporal pattern of spot market demand, might simply serve to attenuate cycles in the spot market price: When a confluence of exogenous factors leads to week t expectations of a "high" price in week $t + 1$, non-cash cattle deliveries will substitute, to some extent, for spot cattle purchases and the anticipated peak in spot prices will turn out to be rather lower than if these substitution possibilities had not been available. (As we have noted in the text of the report, the actions of spot market sellers to exploit the intertemporal arbitrage opportunities available to them also work to "smooth-out" price cycles.) While this is merely a preliminary sketch of how our informal model might be extended to allow for feedback from non-cash cattle delivery scheduling decisions to spot market price determination, it does not appear that the extension would alter our findings appreciably.

IX. DOES THE FORMULA BASE PRICE INFLUENCE SPOT MARKET PRICING CONDUCT?

What we have accomplished up to this point is to demonstrate that the data exhibit a negative relationship between the delivery volumes of cattle procured by non-cash methods and spot cattle prices, but that this negative relationship does not necessarily mean that higher levels of non-cash cattle usage will cause lower spot market cattle prices. By the same token, the negative relationship is not necessarily evidence of "abusive" conduct by packers. To investigate the possibility of abusive or "manipulative" behavior by packers, one must carefully examine the market's institutional arrangements for situations in which the packer would have the opportunity and incentive to engage in such behavior. One conjecture, sometimes put forward by producers, is that packers' spot market pricing conduct is used to manipulate their marketing agreement pricing formula base to their advantage. That is the conjecture examined in this section.

For the four Texas plants during the period of investigation, all cattle delivered under marketing agreements were priced by formulas. The use of formulas, moreover, was reserved almost exclusively for marketing agreement cattle.[67] Generally speaking, formulas involve a base price, that applies to cattle of given quality characteristics (typically defined in terms of a given yield grade, quality grade, and carcass weight

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[67] purchased 13 lots of forward contract cattle on a formula basis. All other lots of spot market and forward contract cattle, for all plants, were priced on a non-formula carcass or live weight basis.

range), and a system of premia and discounts that are used to adjust the base price when delivered cattle characteristics deviate from those of the base carcass. The following table reports the formulas represented in the data and the number of lots purchased under each during the period of investigation.[68]

Packer	Formula	Number of lots
Excel	567	
Excel	Peterson	
Excel	Dimmit	
IBP	Pioneer	
IBP	Cactus	
Monfort	Southern	
Monfort	Original	
Monfort	Caprock	
Monfort	Lubbock	

One important distinction among formulas has to do with whether the base price is derived from a USDA reported price, or from some sort of average price paid by the packer for non-formula cattle in the recent past. For example, the base price for the formula is the weekly weighted average price for steers and heifers, in lots grading 35% - 65% choice, from the USDA Texas-Oklahoma Weekly Average Report (AMS LS721) for the week prior to the week in which the formula-priced cattle are killed. The formulas also use base prices derived from various USDA reported prices the week prior to the kill. The base prices of the remaining formulas are not derived from USDA data, however. The formulas use base prices derived from the weekly average delivered hot cost of non-formula cattle slaughtered at the during the week in which the formula cattle are killed. Thus the cattle establishing the average hot cost for a given week are, for the most part, spot market cattle purchased the previous week. The base prices of the

[68]The formula results in a price to be applied on a live weight basis. All of the others result in carcass weight prices.

formulas are similarly derived except that, in these cases, the weekly average hot cost is an average taken over cattle slaughtered at the [69]

Although feeders determine the week in which marketing agreement cattle will be delivered, packers typically have two weeks advance notice of the volume of scheduled deliveries. When a packer anticipates an unusually large volume of marketing agreement deliveries in a given week, there is an obvious incentive to try to reduce the formula's base price so as to reduce the price that will have to be paid for the formula-priced cattle. When the base price is derived from USDA reported prices, however, there would appear to be little, if any, capability on the part of the packer to manipulate a formula base. When the base price is derived from a one- or two-plant average hot cost, on the other hand, the possibility exists that packers might manipulate the base through strategic conduct in their spot-market (non-formula) purchases the previous week. To see what form such strategic conduct might take, we must examine the base price derivation in a little more detail.

Consider the formula, for example. Again, like all formulas, consists of a base price relevant to a carcass of specific characteristics (the "base carcass") and a system of premia and discounts that are set to adjust the base price when delivered cattle deviate from base carcass characteristics. The derivation of the base price is a quite complicated procedure but its essential features can be summarized as follows. Start with the weekly average delivered hot cost (in the of non-formula cattle slaughtered during the week in which the formula cattle are killed. For the most part, these cattle were purchased during the previous week. Using the premium/discount schedule, calculate a weighted-average premium/discount, called a "grading spread," for the cattle used in the average hot cost calculation. If the week's non-formula cattle graded superior to the base carcass, on average, the grading spread will be positive; if they graded inferior to the base carcass, on average, the grading spread will be negative. This grading spread is then subtracted from the average delivered hot cost to obtain the base price. [70]

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[69]Notice, at this point, that the base prices for the formulas are not set *equal to* the weekly average hot costs; they are merely *derived from* them. Additional detail concerning base price derivations will be introduced presently.

[70]One document we have seen on the formula describes the base price as the average hot cost *plus* the grading spread. This description merely embodies the alternative sign convention in its interpretation of "grading spread." In this alternative interpretation, the grading spread is positive for cattle grading inferior to the base carcass; negative for cattle grading better than the base carcass.

Now suppose, for example, that a lot of formula cattle is of quality exactly comparable, on average, to that of the week's non-formula cattle. The premium/discount calculated for this lot, when added to the base price, would exactly offset the grading spread so that the lot would be paid, on a delivered price per cwt. carcass basis, exactly the week's average delivered hot cost. Lots grading superior to the weighted average quality of the week's non-formula cattle would be paid more than average delivered hot cost; lots grading inferior to average quality would be paid less.

The base price of the formula is similarly derived. The mechanics of the base price derivations for the formulas are quite different, but the effect is the same in the following sense: Formula lots "compete" against the plant's weekly average quality of non-formula cattle. Lots that beat the plant average quality will receive a premium relative to average hot cost of non-formula cattle; lots inferior to plant average quality will sustain a discount.

The practical significance of these methods of base price calculation is as follows: Even when the base price is derived from plant average hot cost (as with the), a packer cannot manipulate the base price simply by purchasing cattle that are inferior relative to the spot market's average quality. Purchasing inferior cattle would reduce average hot cost. But it would also result in a negative grading spread which would offset the hot cost reduction leaving the formula base price approximately unchanged. It is conceivable, however, that a packer could strategically reduce its formula base price by paying lower spot market prices for cattle *of given quality*. Doing so would require that the packer's buyer's bid less aggressively than usual which, of course, would mean that they would succeed in purchasing fewer spot market cattle. Keep in mind, however, that the weeks in which manipulation of the formula base is most appealing (those in which anticipated marketing agreement deliveries are high) are precisely the weeks in which fewer spot market cattle will be needed.

These considerations lead us to Hypothesis 4:

Hypothesis 4: The relationship between marketing agreement cattle deliveries and spot market prices may differ depending upon the type of base price used in the pricing formula. In particular, when the pricing formula is based on the plant's average hot cost, there might be a tendency for the plant to pay relatively low spot prices in a week preceding a week in which a relatively large volume of marketing agreement cattle are delivered. When the pricing formula is based on a USDA reported price, any such tendency may be weaker or non-existent.

To investigate this hypothesis, we need to examine the relationship between the cash prices paid on the spot market for cattle slaughtered each week in a given plant

(or firm) and the plant's (or firm's) weekly volume of deliveries under specific marketing agreements. If we find that weekly relative spot market (non-formula) prices are negatively correlated with weekly marketing agreement deliveries, but only for those marketing agreements with a base price derived from plant hot cost, it would represent evidence of the type of formula base price manipulation suggested by the preceding discussion. Notice that it is the correlation between marketing agreement deliveries and *relative* prices that matters. So in our analysis, we must adjust prices for week-to-week variation in the general cattle price level, and for lot-to-lot variation in cattle quality.

To do this, we begin with a linear multiple regression explaining prices; on a delivered, hot cost basis; as a function of quality characteristics and kill week dummy variables. The sample consists of all spot market lots of fed cattle purchased by the four plants during the sample period.[71] The dependent variable is the lot's total delivered cost divided by carcass weight, in $/cwt. A set of kill week dummies are included to allow for a different intercept for each kill week. Additional explanatory variables include the size of the lot in head; the lot's yield; the percentage of the lot grading prime and choice combined; the distance cattle were shipped to the plant in miles; the percentage of the lot achieving yield grades 1, 2, or 3; separate dummy variables for lots of heifers and for mixed lots of heifers and steers; a dummy variable for lots on which the cash price was quoted on a carcass- (as opposed to live-) weight basis; the lot's average carcass weight in pounds; the square of the lot's average carcass weight; and dummy variables for the purchase day-of-the-week. The results of ordinary least squares (OLS) estimation of this regression equation are reported in Table IX.1. Because this regression is auxiliary to the main inquiry, we relegate a detailed discussion of its results to Appendix D. In what follows, we refer to this regression as the "price regression."

Now consider the residuals from the price regression, the portion of the delivered hot cost of each lot unexplained by the model's independent variables. Because the price regression model allows for a different intercept for each kill week, the OLS residuals for any given kill week will average zero, when averaged across all four plants. A given kill week's residuals for a single plant need not average zero, however. In fact, the average residual for a given plant and for a given kill week provides an indication of the relative prices paid by that plant for spot market cattle slaughtered during that kill week. If the plant's average residual is positive for a given week, it means that the plant's spot market prices for cattle killed that week were "above the market," on a quality adjusted basis. A negative average residual would indicate that the plant purchased cattle killed during the week at quality-adjusted spot market prices that were "below the market," on average.

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[71]Weekend purchases were excluded.

It remains to investigate the correlation between these plant-specific series of weekly average residuals with the weekly volumes of cattle deliveries under specific marketing agreements.[72] One way to do this is with a simple regression of the average residuals on marketing agreement deliveries. Therefore, we use ordinary least squares to estimate a series of regressions of the following form:

$$RES_t = \alpha + \beta M_t + \varepsilon_t, \qquad (10)$$

where RES_t is the head-weighted-average residual from the price regression, for a given plant for week *t*, and M_t is the volume of cattle delivered to the plant in week *t* under marketing agreements using specific pricing formulas. M_t is measured either by the number of head or as a proportion of the week's total slaughter. Data consist of observations for the 67 weeks of the sample for which we have complete information from the four Texas plants. Attention focuses primarily on the algebraic sign and the statistical significance of the estimates of the β parameters. These are reported in Table IX.2.

Once again, the formula base price manipulation strategy proposed in this discussion would manifest itself in a finding of significantly negative estimates of β, but only for those regressions in which the marketing agreement deliveries are priced by formulas using the packer's average hot cost to determine the base ( ). There is no such pattern clearly evident in the results reported in Table IX.2. The estimate of β is negative with a marginal significance level of 6.3% in a one-tailed test (t-statistic = -1.529) in the regression when marketing agreement deliveries are measured in head. But the , regressions also yield negative point estimates with even lower marginal significance levels, even though the base prices are derived from USDA reported figures. The regressions produce negative point estimates of β as well. But here the one-tailed test marginal significance levels are no lower than 10% (t-statistics = -1.124 and -1.278). Consequently, we can not say that these regression results lend support to hypothesis 4. That is, the results do not support the claim that packers try to manipulate formula base prices through their pricing strategies in spot market purchases.

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[72]Actually the analysis is based, not on a simple average of a plant's residuals for each week, but on a weighted average wherein each lot's residual receives a weight equal to the number of head in the lot.

X. FINDINGS AND RECOMMENDATIONS

X.1. Summary of Findings

The main purpose of this research was to investigate the relationship between the use of non-cash methods for procuring fed cattle and the prices packers pay for fed cattle on the spot market. The nature of the data dictated that that investigation be limited to an examination of what we have called "short-run" issues; issues concerning the pattern of week-to-week covariation between spot market prices, on the one hand, and the delivery volumes of cattle procured by non-cash means, on the other. "Long-run" questions; questions about the changes in overall market conditions that one might expect to observe if the use of non-cash procurement methods were banned or severely restricted; are not thoroughly examined.[73] Before undertaking this main inquiry, we addressed two related preliminary questions: Are there quality differences among fed cattle procured by different methods? And, are there quality-adjusted price differences among cattle procured by different methods?

To investigate the possibility of systematic differences in cattle quality across procurement methods, we first compared summary statistics for the distributions of lot-quality indicators (like yield, percentage of the lot grading prime and choice, etc.) across procurement methods. Some generalizations are supported by the results of this comparison. For example, it appears that marketing agreement purchases tend to include a higher proportion of all-steer lots and tend to have at least a slightly higher yield, on average, than lots procured by the other three methods (spot market, forward contract, and packer fed). Other potentially interesting quality comparisons could not be made due to data limitations. For example, we have no basis for determining whether the quality-uniformity of cattle *within a lot* tends to vary systematically across procurement methods.

Because the "quality" of a lot of fed cattle is multi-dimensional, we also used the product characteristic approach to develop summary, dollar-value, indices of the quality of lots procured by various methods. For a given lot, the resulting price index amounts to a forecast of the price that a lot with identical quality characteristics would have brought had it been sold on the spot market, on a live-weight-priced basis, on a given day. As such, it is directly comparable to the values of the index for other lots: Lots of higher quality should have a higher price index. Overall, the results of this analysis

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[73]Our investigation of short-run questions does, however, shed light on the credibility of a commonly-made claim regarding a long-run concern; namely, the claim that a negative correlation between non-cash cattle deliveries and spot prices in weekly data means that restricting the use of non-cash procurement methods will lead to higher spot prices on average.

show evidence of relatively little variation in average lot quality across procurement methods.

The second preliminary question concerned the possibility that there may be quality-adjusted price differences across procurement methods. To address this question, we undertook a multiple regression analysis of lot price (delivered hot cost) as a function of lot quality indicators; other factors which could conceivably influence price, such as the identity of the purchasing plant and the week of purchase; and a set of dummy variables which, for each plant separately, identify the procurement method. From the estimates of the coefficients of these dummy variables, one can infer the differences, in delivered hot cost, between otherwise-identical lots procured by different methods. The results show that each of the four plants pays quality-adjusted, delivered-price "premia" on marketing agreement lots, relative to spot market lots, with the point estimates of these premia ranging from
on a carcass-weight basis. The
also appear to pay quality-adjusted, delivered-price premia on forward contract lots, with point estimates of these premia on the order of $2.00 to $2.50/cwt. on a carcass-weight basis.[74]

Again, this report's main purpose was to investigate the short-run relationship between the use of non-cash procurement methods and spot market prices for fed cattle. We began this inquiry by attempting to characterize the empirical relationship. Specifically, we addressed two questions: 1. What is the empirical relationship, over time, between the relative degree of reliance on non-cash supply sources by a given plant and the spot market prices that that plant pays *relative to the regional average spot price of fed cattle?* and 2. What is the empirical relationship between the overall use of non-cash procurement methods by packers in a given region and the regional spot market's average price? Bearing in mind that any given regional spot market for cattle, at any given point in time, is characterized, not by a single price, but by a *distribution* of prices at which transactions occur, these questions can be rephrased in the following ways: 1. How does a packing plant's degree of reliance on non-cash procurement methods affect the spot prices it pays within the current distribution of transactions prices? and 2. How is the overall use of non-cash supplies by packers in a given region related to the position of the regional spot market's distribution of transaction prices?

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[74]In the case of marketing agreement cattle, these estimated price premia may be reflections of the value to the packer of the transaction cost savings of the use of marketing agreements. Or they may be statistical artifacts due to our inability to control for some lot quality aspects, such as the degree of uniformity of cattle within a lot. In the case of forward contract cattle, there is some tentative evidence to suggest that the premia are attributable to futures market performance that, over the period of investigation, happened to favor basis forward contract sellers over buyers.

Regarding the first question, we find that plants that currently have a higher than average degree of reliance on non-cash procurement methods tend to make spot market purchases at prices slightly below the mean of the distribution, all else equal. Regression results suggest that, for a ten percentage point increase in the non-cash supply proportion of near-term future slaughter, a plant's spot market prices fall by somewhere in the vicinity of $0.02/cwt. to $0.04/cwt. But this does not mean that the use of non-cash procurement methods leads to lower prices received, on average, by feeders who sell cattle on the spot market. The regression results are simply a reflection of the relationship between individual lot transaction prices and the mean of the distribution of transaction prices *given the observed position of the overall distribution*. In other words, the regression results have implications only about the "identities" of packers who happen to buy at "low-end" prices and those who buy at "high-end" prices: Other things equal, packers that currently have a "high" relative degree of reliance on non-cash supplies tend to pay slightly lower-than-average prices while packers that currently have a "low" relative degree of reliance on non-cash procurement methods tend to pay slightly higher-than-average prices. Even if there were no cattle procured via non-cash methods, there would still be a distribution of spot market transaction prices with, at any given point in time, some packers paying above average prices and some paying below average prices. It is conceivable, however, that the use of non-cash supplies, as one source of heterogeneity among packers, may have an effect on the dispersion of the transaction price distribution. The implications of such an effect for packer, feeder, and consumer welfare is an entirely separate issue.

Non-cash procurement methods would pose a potential threat to feeder welfare if their use were responsible for a decrease in the average spot market price, thus shifting the entire distribution of transaction prices. This brings us to the second question relating regional use of non-cash procurement methods and regional average price. Previous studies have uncovered a tendency for regional spot prices to be "low" during periods in which regional deliveries of non-cash supplies are "high." Some suspect that this is evidence of a causal relationship enabling packers to depress spot prices at will merely by increasing their utilization of non-cash procurement methods. As we show, using a variety of price and non-cash supply measures, and alternative statistical procedures, the negative relationship, in the short run, between regional use of non-cash cattle and regional average spot prices is present in our data too. The policy relevance of this empirical finding depends on the nature of the economic mechanism that is responsible for it.

We propose, and subject to preliminary testing, one specific underlying mechanism to explain the observed negative relationship between deliveries of non-cash cattle and spot market prices. Our hypothesis is that the observed empirical regularity is attributable to the incentives confronting the decision-makers responsible for scheduling the delivery of marketing agreement and forward contract cattle.

Marketing agreements normally give feeders the right to determine the number of cattle delivered in a given week. We have argued that feeders have an incentive to schedule a "high" volume of marketing agreement cattle deliveries in a week for which the *ex ante*, two-week-ahead forecast of price was "low." Contracts for forward sales of cattle, on the other hand, typically reserve delivery scheduling rights for the packer. Here too, we have argued that it is in the interest of packers to schedule a "high" volume of contract cattle deliveries in weeks for which a one- (or two-) week-ahead price forecast was "low." Our analysis of the data produced some evidence that actual decisions on the timing of delivery of non-cash cattle do, in fact, respond to these incentives, especially in the case of marketing agreement cattle, the most significant non-cash supply source for the four Texas plants over the period of investigation.

So there is reason to expect that marketing agreement and forward contract deliveries will be negatively correlated with unobserved *ex ante* forecasts of spot market price. But if the decision-makers have good forecasting ability, this correlation could manifest itself in a negative correlation between marketing agreement and forward contract deliveries and the observed *ex post* realizations of price. This, of course, is exactly the kind of empirical relationship between the volume of deliveries of non-cash cattle and spot market prices found, at the regional level, in this and other studies.

This summarizes our hypothesis about the economic mechanism responsible for the empirical regularity of a negative relationship between the use of non-cash procurement methods and spot prices at the regional level. We conclude that

> **. . . the tendency for spot market cattle prices to be "low," other things equal, in weeks in which non-cash cattle deliveries are "high," does not necessarily mean that there is an underlying mechanism whereby large deliveries of non-cash cattle in a particular week *cause* that week's spot market price to fall. Even if week-to-week fluctuations in the spot cattle price in a regional market were generated essentially independently of the region's use of non-cash supply sources, the incentives that influence the delivery scheduling decisions of feeders and packers would still result in a negative correlation between observed spot price and non-cash cattle slaughter in weekly time series data.**

Up to this point, the analysis has established that there is a negative relationship between the use of non-cash procurement methods and spot market cattle prices, but that this negative relationship does not necessarily mean that higher levels of non-cash cattle deliveries will cause lower spot prices. By the same token, the results of the analysis do not absolve packers of noncompetitive conduct. To investigate the possibility of abusive conduct, one must carefully examine the market's institutional arrangements for situations in which the packer would have the opportunity and incentive to engage in such behavior. One conjecture, sometimes put forward by cattle

feeders, is that packers' spot market pricing conduct is used to manipulate their marketing agreement pricing formula base to their advantage.

Although feeders determine the number of marketing agreement cattle to be delivered to a packer in any one week, packers typically have two weeks advance notice of the volume of scheduled deliveries. When a packer anticipates an unusually large volume of marketing agreement deliveries in a given week, it has an incentive to try to reduce the pricing formula's base price so as to reduce the price that will have to be paid for the marketing agreement cattle. When the base price is derived from a USDA reported price, however, there would appear to be little, if any, capability on the part of the packer to manipulate the formula base. When the base price is derived from a one- or two-plant average hot cost, on the other hand, the possibility exists that the packer might manipulate the base through strategic conduct in its spot market (non-formula) purchases the previous week. In particular, when the pricing formula is based on the plant's average hot cost, there might be a tendency for the plant to pay relatively low spot prices in a week preceding a week in which a relatively large volume of marketing agreement cattle are delivered. When the pricing formula is based on a USDA reported price, any such tendency may be weaker or non-existent. So we examined the relationship between relative spot prices (this week) and the (next week's) volume of marketing agreement deliveries, for both cases: deliveries priced by a formula with a base derived from a USDA report, and deliveries priced by a formula with a base derived from plant hot cost. We found that

> **. . . the econometric results do not lend support to the hypothesis that packers try to manipulate formula base prices through their pricing strategies in spot market purchases.**

X.2 Recommendations

In light of our results, we recommend that the agency should not rely on the statistical finding of a negative correlation between deliveries of cattle procured by non-cash methods and spot market prices as evidence of intent by packers to depress cattle prices through the use of non-cash supply sources, or as evidence of the unintentional consequence of lower prices as a result of non-cash supply use. The agency should be cognizant, however, that certain pricing mechanisms may be more conducive to noncompetitive conduct than others. For example, it stands to reason that when the formula base price is derived from an "in-house" average hot cost rather than a USDA reported price, there is a potential for manipulation of the formula base through spot market pricing conduct. We make this cautionary note in spite of the fact that we found no clear evidence of such abuse in the Texas panhandle data. Also, should the trend toward increased use of non-cash procurement methods continue, thus further thinning the spot market, spot prices will become increasingly less reflective of the forces of supply and demand. Under those circumstances, the cash market may no longer be

the appropriate point in the beef marketing channel at which the formula base price should be derived.